IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants :Masaharu UDAGAWA et al.

Group Art Unit : 2611

Appl. No. : 10/598,695

Examiner : Jean B. CORRIELUS

Filed : September 8, 2006

Confirmation No. : 9058

For : TRANSMISSION DEVICE AND RADIO COMMUNICATION DEVICE

SUGGESTED REVISIONS TO THE APPLICATION TO ASSIST THE EXAMINR IN PREPARING AN EXAMINER'S AMENDMENT

Commissioner for Patents
U.S. Patent and Trademark Office
Customer Service Window, Mail Stop Amendment
Randolph Building
401 Dulany Street
Alexandria, VA 22314

Sir:

Pursuant to a telephone request by the Examiner, Applicant herewith submits the following suggested revisions to the application to assist the Examiner in his preparation of an Examiner's Amendment, in order to pass the present application to issue.

Suggested Amendments to the Drawings begin on page 2 of this paper.

Suggested Amendments to the Specification begin on page 3 of this paper.

Suggested Amendments to the Claims are reflected in the listing of claims that begin on page 22 of this paper.

Remarks begin on page 25 of this paper.

An **Appendix** containing three suggested replacement sheets of drawings are attached hereto following page 26 of this paper.

SUGGESTED AMENDMENTS TO THE DRAWINGS

Applicant herewith submits three (3) sheets of replacements drawings to replace Figs. 2, 4 and 6 originally filed in the application. The replacement sheets are attached hereto following the last page of this document.

In Fig. 2, the label for element 201 is changed from “Variable Gain Amplification Section” to ---Variable Gain Amplifier---. Elements 202 and 203 are each changed from “Variable Gain Amplifier” to ---Amplifier---.

In Fig. 4, the input to the element 120 is changed from “Output of Variable Amplifier 203” to ---Output of Amplifier 203---.

In Fig. 6, the heading “210 : Variable Gain Amplification Section” is changed to ---210 : Variable Gain Amplifier---.

Attachment:

Three (3) sheets of Replacement Drawings containing Figs. 2, 4 and 6

SUGGESTED AMENDMENTS TO THE SPECIFICATION

Please amend paragraph [0012] of the specification, as follows:

[0012] In order to solve the above problems, one aspect of the transmission apparatus of the present invention employs a configuration of a transmission apparatus using a polar modulation scheme, and this transmission apparatus has: an amplitude phase separation section that separates baseband modulation data into a baseband amplitude modulation signal and a baseband phase modulation signal; a phase modulation section that modulates a high frequency carrier signal based on the baseband phase modulation signal and forms a high frequency phase modulation signal; a variable gain ~~amplification section~~ amplifier that is provided in a later stage of the phase modulation section and amplifies the high frequency phase modulation signal; and a high frequency power amplifier that is provided in a later stage of the variable gain ~~amplification section~~ amplifier and amplifies power of the high frequency phase modulation signal amplified by the variable gain ~~amplification section~~ amplifier, wherein the variable gain ~~amplification section~~ amplifier has a linear-log conversion circuit that linear-log converts the baseband amplitude modulation signal, and ~~a variable gain~~ an amplifier that amplifies the high frequency phase modulation signal based on the linear-log converted baseband modulation signal and a gain control signal.

Please amend paragraph [0013] of the specification, as follows:

[0013] According to this configuration, since the variable gain ~~amplification section~~ amplifier is provided, as compared with the case where all amplification processing of the high frequency phase modulation signal is performed by the high frequency power amplifier, it is possible to perform amplification processing taking into account performance of the high frequency power amplifier and obtain transmission output power with wide dynamic range by combining amplification processing of the high frequency power amplifier and the variable gain ~~amplification section~~ amplifier. That is, by controlling a gain of the variable gain ~~amplification section~~ amplifier and thereby controlling the level of the high frequency phase modulation signal inputted by the high frequency power amplifier, it is possible to reduce the leakage power. As a result, with the high frequency power amplifier, it is possible to extend the output power control range by the supply voltage.

Please amend paragraph [0014] of the specification, as follows:

[0014] In addition, the variable gain ~~amplification section~~ amplifier has a linear-log conversion circuit that linear-log converts a baseband amplitude modulation signal and ~~a variable gain~~ an amplifier that amplifies a high frequency phase modulation signal based on the linear-log converted baseband amplitude modulation signal and a gain control

signal so that the ~~variable gain~~ amplifier can perform both average signal level control by the gain control signal and instantaneous amplitude control based on the baseband amplitude modulation signal on the high frequency phase modulation signal, and it is possible to simplify the configuration on a signal line for amplifying the high frequency phase modulation signal. With a simple configuration in which, for example, a plurality of stages of ~~variable gain~~ amplifiers are provided or the same ~~variable gain~~ amplifier is shared, it is possible to apply both average signal level control based on the gain control signal and instantaneous amplitude fluctuation control based on the baseband amplitude modulation signal to the high frequency phase modulation signal.

Please amend paragraph [0015] of the specification, as follows:

[0015] Another aspect of the transmission apparatus of the present invention adopts a configuration wherein the variable gain ~~amplification section~~ <u>amplifier</u> further has an adder circuit that adds the baseband amplitude modulation signal linear-log converted by the linear-log conversion circuit and the gain control signal, and the ~~variable gain~~ amplifier amplifies the high frequency phase modulation signal based on the signal added by the adder circuit.

Please amend paragraph [0016] of the specification, as follows:

[0016] According to this configuration, since average signal level control and instantaneous amplitude control can be performed by the same ~~variable gain~~ amplifier, it is possible to correspondingly reduce the number of stages of ~~variable gain~~ amplifiers and thereby reduce the circuit scale.

Please amend paragraph [0018] of the specification, as follows:

[0018] According to this configuration, in the first operation mode (for example, in the case of obtaining high level transmission output power), by operating the high frequency power amplifier as a nonlinear amplifier, it is possible to significantly improve power efficiency. Furthermore, in the second operation mode (for example, in the case of obtaining low level transmission output power), the high frequency power amplifier is made to operate as a linear amplifier, and amplitude control by the baseband amplitude modulation signal and the gain control signal is performed at the variable gain ~~amplification section~~ amplifier. As a result, it is possible to maintain high power efficiency of the high frequency power amplifier and well perform average signal level control by the gain control signal and instantaneous amplitude control by the baseband modulation signal on the high frequency phase modulation signal over a wide range.

Please amend paragraph [0019] of the specification, as follows:

[0028] On the other hand, baseband phase modulation signal S3 is first inputted to frequency synthesizer 106. Frequency synthesizer 106 obtains high frequency phase modulation signal S4 by phase modulating carrier frequency at baseband phase modulation signal S3 and transmits this signal to variable gain ~~amplification section~~ amplifier 201.

Please amend paragraph [0029] of the specification, as follows:

[0029] Variable gain ~~amplification section~~ amplifier 201 has two ~~variable gain~~ amplifiers 202 and 203, linear-log conversion section 206, digital-analog conversion circuits (D/A) 204 and 207, and low-pass filters (LPF) 205 and 208.

Please amend paragraph [0030] of the specification, as follows:

[0030] Variable gain ~~amplification section~~ amplifier 201 inputs baseband amplitude modulation signal S2 outputted from switch 111 to linear-log conversion section 206. Linear-log conversion section 206 log-converts baseband amplitude modulation signal S2

and outputs the result. The manner of this linear-log conversion is not described in detail, but can be readily implemented by a known digital signal processing circuit. The log converted baseband amplitude modulation signal is inputted to ~~variable gain~~ amplifier 203 as a gain control signal of ~~variable gain~~ amplifier 203 via digital-analog conversion circuit (D/A) 207 and low-pass filter (LPF) 208.

Please amend paragraph [0031] of the specification, as follows:

[0031] Furthermore, variable gain ~~amplification section~~ amplifier 201 provides gain control signal S21 to ~~variable gain~~ amplifier 202 as a gain control signal of ~~variable gain~~ amplifier 202 via digital-analog conversion circuit (D/A) 204 and low-pass filter (LPF) 205.

Please amend paragraph [0032] of the specification, as follows:

[0032] Gain control signal S21 is a signal in which an offset corresponding to gain offset signal S20 is added to gain control signal S12 by adder 110. This gain offset signal S20 is set to ~~variable gain~~ amplifier 202 so that a signal of the level suitable for making high frequency power amplifier 105 operate as a nonlinear amplifier in saturation operation or

switching operation area, can be obtained. ~~Variable gain amplifier~~ Amplifier 202 amplifies high frequency phase modulation signal S4 according to gain control signal S21 and transmits the amplified signal to ~~variable gain~~ amplifier 203.

Please amend paragraph [0033] of the specification, as follows:

[0033] Either baseband amplitude modulation signal S2 or baseband amplitude modulation signal S2 in which a lower limit value is limited by lower limit value limitation circuit 112, is inputted to linear-log conversion section 206 via switch 111. In addition, lower limit value limitation circuit 112 limits a lower limit value for amplitude fluctuation of baseband amplitude modulation signal S2. By this means, ~~variable gain~~ amplifier 203 performs amplitude modulation on the output signal of ~~variable gain~~ amplifier 202 based on either baseband amplitude modulation signal S2 in which a lower limit value is limited or baseband amplitude modulation signal S2 in which a lower limit value is not limited, and transmits the result to high frequency power amplifier 105.

Please amend paragraph [0034] of the specification, as follows:

[0034] High frequency power amplifier 105 amplifies the high frequency phase

modulation signal outputted from variable gain ~~amplification section~~ amplifier 201 using the supply voltage value supplied from amplitude modulation signal amplifier 104 and obtains transmission output signal S30.

Please amend paragraph [0040] of the specification, as follows:

[0040] On the other hand, as for high frequency phase modulation signal S4, when the level of transmission output signal S30 is relatively large, terminal a and terminal c of switch 111 are connected by mode switching signal S10. As a result, a signal in which the amplitude fluctuation lower limit value of baseband amplitude modulation signal S2 is limited by lower limit value limitation circuit 112, is inputted to linear-log conversion section 206 of variable gain ~~amplification section~~ amplifier 201 via switch 111. By this means, the output signal of ~~variable gain~~ amplifier 202 is amplitude modulated at ~~variable gain~~ amplifier 203 based on baseband amplitude modulation signal S2 in which a lower limit value is limited, and transmitted to high frequency power amplifier 105.

Please amend paragraph [0041] of the specification, as follows:

[0041] Here, generally, voltage gain V_{out}/V_{IN} between input and output of a variable gain

amplifier is an exponential function of a gain control signal. Taking this into consideration, in this embodiment, by log converting baseband amplitude modulation signal S2 at linear-log conversion section 206 and supplying the result as a gain control signal of ~~variable gain~~ amplifier 203, ~~variable gain~~ amplifier 203 is adapted to implement linear operation for baseband amplitude modulation signal S2. In other words, by providing linear-log conversion section 206, it is possible to implement multiplication of high frequency phase modulation signal S4 and baseband amplitude modulation signal S2 using ~~variable gain~~ amplifier 203.

Please amend paragraph [0042] of the specification, as follows:

[0042] In this way, by performing multiplication by ~~variable gain~~ amplifier 203 with baseband amplitude modulation signal S2 as a gain, it is possible to perform average signal level control by gain control signal S12 and instantaneous amplitude control by baseband amplitude modulation signal S2 using a variable gain amplifier of the same configuration. By this means, amplifiers can be readily manufactured.

Please amend paragraph [0043] of the specification, as follows:

[0043] Furthermore, the variable gain ~~amplification section~~ amplifier of the present invention, actually, is not simply divided into two blocks as shown in FIG.2, and, for example, two out of three dependently connected variable gain amplifiers are used as ~~variable gain~~ amplifier 202 for controlling the average signal level, and the other one is used as ~~variable gain~~ amplifier 203 for performing instantaneous amplitude control. In this case, as described in this embodiment, if average signal level control and instantaneous amplitude control can be performed on the similar variable gain amplifier, it is possible to readily change the number of variable gain amplifiers assigned for each control according to specifications. This increases the versatility and improves the usability.

Please amend paragraph [0050] of the specification, as follows:

[0050] In this embodiment, linear-log conversion section 206 performs log conversion, and then ~~variable gain~~ amplifier 203 multiplies an exponent. Therefore, the output becomes linear as a result. When an inverse function of equation (5) is applied to the linear-log conversion performed at linear-log conversion section 206, ~~variable gain~~ amplifier 203 can perform accurate linear amplification. Furthermore, when input is small enough, if an inverse function of the approximation of equation (8) is applied to the linear-log conversion performed at linear-log conversion section 206, there is practically no problem.

Please amend paragraph [0053] of the specification, as follows:

[0053] In this way, according to this embodiment, by providing linear-log conversion section 206 and ~~variable gain~~ amplifier 203, log-converting baseband amplitude modulation signal S2 and setting the log-converted signal as a gain control signal of ~~variable gain~~ amplifier 203, it is possible to provide instantaneous amplitude fluctuation by baseband amplitude modulation signal S2 at ~~variable gain~~ amplifier 203. As a result, both average signal level control by gain control signal S12 and instantaneous amplitude fluctuation control by baseband amplitude modulation signal S2 can be performed on high frequency phase modulation signal S4 at a variable gain amplifier so that it is possible to simplify the configuration on a signal line for amplifying high frequency phase modulation signal S4, and also increase the versatility and improve the usability.

Please amend paragraph [0054] of the specification, as follows:

[0054] Furthermore, since the linear-log converted value is digital-analog converted and provided to ~~variable gain~~ amplifier 203, compared to the case of digital-analog converting an antilogarithm, the number of bits required at D/A 207 is reduced. As a

result, it is possible to simplify the configuration of D/A 207 and reduce the processing time.

Please amend paragraph [0055] of the specification, as follows:

[0055] Still further, in this embodiment, variable gain ~~amplification section~~ amplifier 201 is provided in the anterior stage of high frequency power amplifier 105. In the first operation mode, a supply voltage changed according to baseband amplitude modulation signal S2 and gain control signal S12 is supplied to high frequency power amplifier 105 so that high frequency power amplifier 105 operates as a nonlinear amplifier, and thereby amplitude modulation according to baseband amplitude modulation signal S2 and gain control signal S12 is performed by high frequency power amplifier 105. In the second operation mode, a fixed supply voltage is supplied to high frequency power amplifier 105 so that high frequency power amplifier 105 operates as a linear amplifier, and thereby amplitude modulation according to baseband amplitude modulation signal S2 and gain control signal S12 is performed by variable gain amplification section 201. It is thereby possible to maintain high power efficiency of high frequency power amplifier 105 and implement efficient average signal level control by gain control signal S12 and efficient instantaneous amplitude control by baseband amplitude modulation signal S2 on high frequency phase modulation signal S4 over a wide range.

Please amend paragraph [0058] of the specification, as follows:

[0058] FIG.5 shows the relationship between a supply voltage and an output voltage of nonlinear amplifier 120. As shown in FIG.5, at nonlinear amplifier 120, the square of a supply voltage is proportional to the output voltage. Here, the amount of leakage power is determined by parasitic capacity 121 and the input signal level of nonlinear amplifier 120 (the output signal level of variable gain ~~amplification section~~ amplifier 201).

Please amend paragraph [0059] of the specification, as follows:

[0059] Here, in the case of not providing variable gain ~~amplification section~~ amplifier 201, since the output of frequency synthesizer 106 is substantially constant, the leakage power is also constant. In that case, in order to reduce the level of transmission output signal S30, the supply voltage of nonlinear amplifier 120 is reduced, but the reduction is restricted by the leakage power, and the output level cannot be reduced more than a fixed value.

Please amend paragraph [0060] of the specification, as follows:

[0060] On the other hand, in this embodiment, by controlling the gain of ~~variable gain~~ amplifier 202 by gain control signal S12 and controlling the level of a high frequency phase modulation signal to be inputted to high frequency power amplifier 105, it is possible to reduce the leakage power. Therefore, at high frequency power amplifier 105, it is possible to extend the output power control range by the supply voltage.

Please amend paragraph [0061] of the specification, as follows:

[0061] Furthermore, ~~variable gain~~ amplifier 203 performs amplitude modulation on the output signal of ~~variable gain~~ amplifier 202 based on baseband amplitude modulation signal S2, and thereby the input level of high frequency power amplifier 105 follows instantaneous level fluctuation of baseband amplitude modulation signal S2 and the leakage power is reduced so that it is possible to improve reproducibility of instantaneous level fluctuation. That is, input of high frequency power amplifier 105 can be controlled according to instantaneous output power.

Please amend paragraph [0064] of the specification, as follows:

[0064] On the other hand, as for high frequency phase modulation signal S4, when the level of transmission output signal S30 is relatively small, terminal b and terminal c of switch 111 are connected by mode switching signal S10, baseband amplitude modulation signal S2 in which a lower limit value is not limited is inputted to linear-log conversion section 206, amplitude modulation is performed on the output signal of ~~variable gain~~ amplifier 202 at ~~variable gain~~ amplifier 203 based on this baseband amplitude modulation signal S2, and the result is outputted to high frequency power amplifier 105.

Please amend paragraph [0065] of the specification, as follows:

[0065] Furthermore, when the level of transmission output signal S30 is relatively small, gain offset signal S20 is set at zero, and gain control signal S21 without an offset is inputted to ~~variable gain~~ amplifier 202. High frequency power amplifier 105 linear-amplifies output of ~~variable gain~~ amplifier 203 under the fixed supply voltage supplied from amplitude modulation signal amplifier 104 and obtains transmission output signal S30.

Please amend paragraph [0067] of the specification, as follows:

[0067] That is, when the level of transmission output signal S30 is relatively large, high frequency power amplifier 105 is used as a nonlinear amplifier, and instantaneous amplitude control based on baseband amplitude modulation signal S2 and average output level control based on gain control signal S12 are performed at the supply voltage applied to high frequency power amplifier 105. When the level of transmission output signal S30 is relatively small, high frequency power amplifier 105 is used as a linear amplifier, and instantaneous amplitude control and average output level control are performed at variable gain ~~amplification section~~ amplifier 201 provided in the anterior stage of high frequency power amplifier 105. By this means, it is possible to control the level of transmission output signal S30 over a wide range.

Please amend paragraph [0068] of the specification, as follows:

[0068] Furthermore, when high frequency power amplifier 105 performs nonlinear operation, by controlling a gain of ~~variable gain~~ amplifier 202 according to gain control signal S12 and varying the level of high frequency phase modulation signal S4, it is possible to reduce the leakage power at high frequency power amplifier 105 and consequently extend the output power control range by the supply voltage.

Please amend paragraph [0069] of the specification, as follows:

[0069] (Embodiment 2)

A case has been described above with Embodiment 1 where the case has been described where only instantaneous amplitude fluctuation by baseband amplitude modulation signal S2 is provided by ~~variable gain~~ amplifier 203, but with this embodiment, average signal level control in addition to instantaneous amplitude fluctuation control by baseband amplitude modulation signal S2 is performed at ~~variable gain~~ amplifier 203.

Please amend paragraph [0070] of the specification, as follows:

[0070] FIG.6 shows a configuration example to realize this. In FIG.6, in which the same reference numerals are assigned to the parts corresponding to FIG.2, variable gain ~~amplification section~~ amplifier 210 adds a log-converted baseband amplitude modulation signal and gain control signal 2 at adder 211. By this means, at ~~variable gain~~ amplifier 203, it is possible to provide instantaneous amplitude fluctuation by baseband amplitude modulation signal S2 and average signal level fluctuation by gain control signal 2. Then, average signal level control is assigned to ~~variable gain~~ amplifier 202 and ~~variable gain~~ amplifier 203 so that it is possible to reduce the number of stages of ~~variable gain~~

amplifier 202 and thereby reduce the circuit scale. Furthermore, even in the case where the performance of variable gain amplifiers is limited for a gain control signal, it is possible to perform amplification processing with sufficiently wide dynamic range according to the gain control signal.

Please amend paragraph [0071] of the specification, as follows:

[0071] Still further, in FIG.6, average signal level control according to gain control signal 1 is performed at ~~variable gain~~ amplifier 202, but, in some cases, instantaneous amplitude control and average signal level control can be performed by ~~variable gain~~ amplifier 203 alone, and therefore it is possible to further reduce the circuit scale.

Please amend the Abstract of the application, as follows:

A transmission device having a preferable power efficiency and a wide control range of transmission output power. A pre-stage side of a high-frequency power amplifier changes an amplitude of a high-frequency phase modulation signal according to a base band amplitude modulation signal and a gain control signal. A variable gain amplifier changes the amplitude of the high-frequency phase modulation signal according to the base band amplitude modulation signal and the gain control signal, so that the base band amplitude modulation signal is supplied to ~~a variable gain~~ an amplifier via a linear-log converter.

SUGGESTED AMENDMENTS TO THE CLAIMS

This listing of claims is suggested to replace all prior versions and listings of claims in the application, as follows:

Listing of Claims

1(currently amended). A transmission apparatus using a polar modulation scheme, comprising:

an amplitude phase separator that separates baseband modulation data into a baseband amplitude modulation signal and a baseband phase modulation signal;

a phase modulator that modulates a high frequency carrier signal based on the baseband phase modulation signal and forms a high frequency phase modulation signal;

a variable gain amplifier that is provided in a later stage of said phase modulator and amplifies the high frequency phase modulation signal; and

a high frequency power amplifier that is provided in a later stage of said variable gain amplifier and amplifies power of the high frequency phase modulation signal amplified by said variable gain amplifier,

wherein said variable gain amplifier comprises:

a linear-log converter that linear-log converts the baseband amplitude modulation signal; and

an ~~a variable gain~~ amplifier that amplifies the high frequency phase modulation signal based on the linear-log converted baseband amplitude modulation signal and a gain control signal.

2 (currently amended). The transmission apparatus according to claim 1, wherein:

said variable gain amplifier further comprises an adder that adds the baseband amplitude modulation signal linear-log converted by said linear-log converter and the gain control signal; and

said ~~variable gain~~ amplifier amplifies the high frequency phase modulation signal based on the signal added by said adder ~~circuit~~ .

3 (previously amended). The transmission apparatus according to claim 1, further comprising a supply voltage supplier that supplies a first supply voltage, that varies according to the baseband amplitude modulation signal and the gain control signal to said high frequency power amplifier in a first operation mode, and supplies a second supply voltage, that is fixed, to said high frequency amplifier in a second operation mode, wherein said high frequency power amplifier operates as a non-linear amplifier using the first supply voltage in the first operation mode and operates as a linear amplifier using the second supply voltage in the second operation mode.

4 (previously amended). A radio communication apparatus, comprising:

a transmission processor that comprises the transmission apparatus according to claim 1;

a reception processor that demodulates a received signal;

an antenna; and

a transmission/reception switcher that switches between supplying a transmission signal from said transmission processor to said antenna and supplying the received signal

from said antenna to said reception processor.

REMARKS

Pursuant to a telephone request made by the Examiner on June 16, 2009, Applicant herewith provides proposed amendments to the specification for the purpose of enabling the Examiner to make an Examiner's Amendment in order to pass the application to issue.

During the above-noted telephone request, the Examiner noted that claim 1 referred to two instances of "a variable gain amplifier". Accordingly, it was suggested that the second instance of "a variable gain amplifier" found in the last paragraph of claim 1 be changed to ---an amplifier--, which the Examiner said he could do by an Examiner's amendment. The Examiner also noted that a similar revision would be necessary in the last paragraph of claim 2.

The Examiner thereafter requested revision of the specification and drawings to ensure conformance of the specification with the revised claims, and requested that Applicant indicate the sections of the specification that require revision, in order to assist the Examiner in the preparing the Examiner's Amendment. Pursuant to the Examiner's Request, Applicant herewith indicates the paragraphs of the specification that are to be revised, and the labeling in Figs. 2, 4 and 6 that are to be revised, pursuant to the Examiner's request.

Furthermore, Applicants also provide a listing of claims that reflect the revisions discussed with the Examiner, to ensure that the claims are properly revised by the Examiner in the Examiner's Amendment.

Should there be any question, the Examiner is requested to contact the undersigned.

Respectfully Submitted,
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